complex conjugate) or if $|Z1 - Z2^*|^2 < 0.5\ |Z1+Z2|^2$. This definition is typically applied to linear circuits, but in many cases, especially with non-linear power conditioning circuits, equivalent impedance can be derived while taking into account the non-linearity. In some cases the equivalent impedance can also be time-varying, especially when energy storage components are involved in the system. In certain scenarios, due to limitations of the transducer, matching network, and power recovery circuits, an exact impedance match may not be achievable; in those cases, impedance match refers to maximum possible impedance match that can be obtained or within 50% of the maximum possible impedance match.

[0036] In preferred embodiments, the acoustic frequency is controlled by the system controller such that the end to end power transmission efficiency from transmitter to load is locally maximal. More specifically, perturbations to the system operating point will cause the controller to seek a frequency that provides increased or maintained efficiency relative to the pre-perturbation operating point. System control according to this principle is expected to inherently result, in most cases, in impedance matching and operating with the acoustic transducer in its inductive band as described above.

[0037] The acoustic transmitter can be configured to provide continuous acoustic radiation. Here the acoustic frequency is varied continuously by the system controller. Alternatively, the acoustic transmitter can be configured to provide pulsed acoustic radiation. Here the acoustic frequency can be varied from pulse to pulse and/or varied within pulses by the system controller.

[0038] The controlled system parameters can be parameters including but not limited to: power from the acoustic transmitter, beam pattern of the acoustic radiation, phase of the acoustic radiation, pulse duration of the acoustic radiation, and duty cycle of the acoustic radiation.

[0039] The properties of the Tx such as its efficiency, transmission power, impedance, and beam pattern can be controlled by system parameters such as operating frequency, input power level, or time delay between elements on the Tx. For instance, if the implant drifts or rotates in any direction, the Tx can be adaptively beam-formed in order to maintain maximum efficiency. Additionally, the transmitted power could also be increased if the Rx platform rotates or drifts, in order to support a given load power. The transmitted power could also be increased if the load requirement increases or if the system detects a low available power at the Rx due to any variations. Similarly, the transmitted power could be reduced and operating frequency can be changed when the load requirement drops or the system detects a greater than required available power at the Rx due to any variations. An adaptive matching network and driving circuits can be added to the Tx in order maximize the system efficiency. Certain link aberrations may also require changing the phase of the Tx output waveform, changing the ON time of the Tx, or changing the duty cycle of the Tx output waveform. For instance, the Tx can provide power in bursts of energy with an adaptable duty cycle, rather than continuously providing power for a particular duration.

[0040] The system variables being monitored can include but are not limited to: load impedance, acoustic transmitter efficiency, acoustic transmitter impedance, acoustic transmitter beam pattern, distance between the acoustic transmitter and the receiver unit, transmission efficiency between the acoustic transmitter and the receiver unit, receiver unit efficiency, receiver unit impedance, receiver unit aperture, changes in parameters of the power recovery circuit, and changes in parameters of the adaptively reconfigurable electrical impedance matching network.

[0041] The electrical load can provide various functions, including but not limited to: electrical stimulation, optical stimulation, acoustic stimulation, neural recording, temperature sensing, pressure sensing, drug sensing, impedance sensing, detecting biological species, heating, and data communication. The electrical load can be an energy storage device, such as a battery or a capacitor.

[0042] For charging a rechargeable battery or a storage capacitor on the Rx, the transmitted power profile can be shaped such that power delivery efficiency is maximized to reach a desired voltage level on the battery or capacitor. By adjusting the transmitted power profile from Tx, available power from Rx can thus be controlled continuously. To efficiently charge an energy storage element to a certain voltage with a given time, a ramp profile of the transmitted power of Tx is desired. The voltage level of the battery or capacitor can be sensed and communicated back to the Tx unit. The operation of the Tx and Rx, matching network, and power recovery circuit can be adapted to optimize the total link efficiency.

[0043] Electrical loads determine the operating condition of the implant. The implant may be equipped with several functionalities, such as electrical or optical stimulation, neural recording, temperature and pressure sensing, and data communication, which require different power levels. For certain embodiments, system performs load interrogation and dynamic system calibration for overall maximum power transfer efficiency for electrical stimulation implants. The implant can continuously or periodically monitor the impedance of the tissue between electrodes and adjust the system parameters including, but not limited to, the power transfer frequency.

[0044] In some cases the electrical load is fixed rather than dynamic. System control as described herein can still be performed, where the system can be regarded as responding to perturbations in system operation such as change of environment or physiological state other than changes in the load by altering at least the acoustic frequency to optimize power transfer to the load.

[0045] The system controller can have sensors including but not limited to: load power sensor, load voltage sensor, load current sensor, output electrical AC signal voltage sensor, transducer output impedance sensor, transducer output voltage sensor, transducer output current sensor, receiver unit temperature sensor, and acoustic transmitter temperature sensor. For example, if the load on FIG. **2** is a battery, a load voltage sensor can be used to monitor how charged or discharged the battery is (i.e. the voltage level of the battery).

[0046] In order to determine desired system parameters and internal block parameters, and to know when they should be varied, sensing of key system metrics is preferably performed. For instance, monitoring the load power, output voltage or current, input voltage of the power recovery circuit, receiver impedance or voltage, the Tx voltage are just some of the metrics which can be useful for characterizing the system. Once desired system parameters are determined, then the entire system can be reconfigured Examples of sensors are capacitor voltage or load current sensor, and